HOUSING DEVELOPMENTS FOR ELECTRIC FACTORY, BANGALORE, INDIA

by

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INTRODUCTION

Ever since the dawn of civilization, man was seeking for a sheltered space to cook, wash, spend his leisure time and sleep. He wished to have a kind of healthful and pleasant environment for his children to play and grow. This is a natural urge and a basic necessity of life.

As civilization advanced, the problem of housing gained importance. Today, with the developments going on in every field and direction and as cities of the world are growing at a phenomenal rate, the need for better housing and the urge for a decent living environment is much greater.

In the words of Lewis Mumford, "Today, we face not only the original social disruption, we likewise face the accumulated physical and social results of that disruption: ravaged landscape, disorderly urban districts, pockets of disease, patches of blight, mile upon mile of standardized slums, worming into the outlying areas of big cities and fusing with their ineffectual suburbs." In short: a miscarriage and defeat of civilized effort.

This is more true for a developing country like India, the second most populous country in the world, which is experiencing its initial stage of progress and construction. The country, plagued by poverty and lack of planning, is hardpressed to house its 439.235 million people, adequately and properly.

Rapid industrialization followed independence in 1947. This sudden impact of industrialization has resulted in a tremendous growth of the urban population within a short period. The urban population in India increased 21.5% between 1951 and 1961. In 1963, there were 106 cities, with a population of 100,000 or more, experiencing industrial expansion. Today a majority of cities are therefore overcrowded, with acute shortage of housing and lack

of proper housing facilities. Though considerable progress has been accomplished through public and industrial housing by Union and State Governments, much remains to be done. There is an increasing demand for architects and planners to help provide decent housing environments with limited funds.

The country is fast changing from an agrarian economy to an industrial economy and the factory is becoming the nucleus of the new urban organism. Better housing for employees is the need to stimulate employment, and assure further industrialization that will ultimately contribute to the progress of the country.

With these thoughts in mind, the present study deals with the housing development for an industrial complex, a New Government Electric Factory in Bangalore, India. A sincere attempt has been made to economically provide quality design. Sociological, economical and climatic factors are taken into consideration in the systematic approach from site analysis to final design concept.

Building materials and construction techniques employed in many of the western countries may not be suitable for India. Attempts should therefore be made to use indiginous materials and techniques. Developing a housing character reflecting the new urban way of life in India, while recognizing the climate and the economic considerations, is the intent of the study.

The thesis is divided into four parts. The first part describes the land and the people of India, including developments of dwelling houses from the historic past to the present.

The second part describes Bangalore City, its background and growth to its present position as a major industrial city resulting in a housing shortage and also the Electric Factory is described in detail.

A plan, recognizing the housing needs, is developed in the third part.

Housing objectives and standards are discussed and employees' living standards, cultural and social habits were analyzed.

Lastly, part four analyzes the designs proposed for the type of houses required by the three income groups. Economical designs were achieved through careful selection of materials and methods of construction. Improved services and utilities were provided.

The text is supplemented by architectural drawings presented on nine illustration boards. The architectural drawings consist of plans, elevations, sections, perspectives and construction details of the three types of houses proposed. A general site development plan is also included, relating the various site functions and structures.

INDIA AT A GLANCE

Area and Physical Features - India, also known as Bharath, is the seventh largest and second most populous country in the world. It has an area of 3,267,500 sq. Km. The country stretches 3,200 Km. north to south and has a land frontier of 15,200 Km. and a coastline of 5,700 Km. (See Plate I for map of India.)

Lying entirely in the northern hemisphere, the mainland extends between latitudes $8^{\circ}4'$ and $37^{\circ}6'$ north and longitudes $68^{\circ}7'$ and $97^{\circ}25'$ east. In the north, India is separated from China by the great Himalayas, and mountains also separate India from Burma on the eastern border. To the northwest lies West Pakistan.

In the south, the country stretches across the Tropic of Cancer and forms a peninsula, with the Arabian Sea to the west and the Bay of Bengal to the east. Off the eastern tip of the country lies Ceylon.

The Indian Peninsula can be divided into three regions according to physical and geographical conditions:

1. Snow clad Himalayan range
2. The plains of northern India
3. The Deccan or Peninsula proper

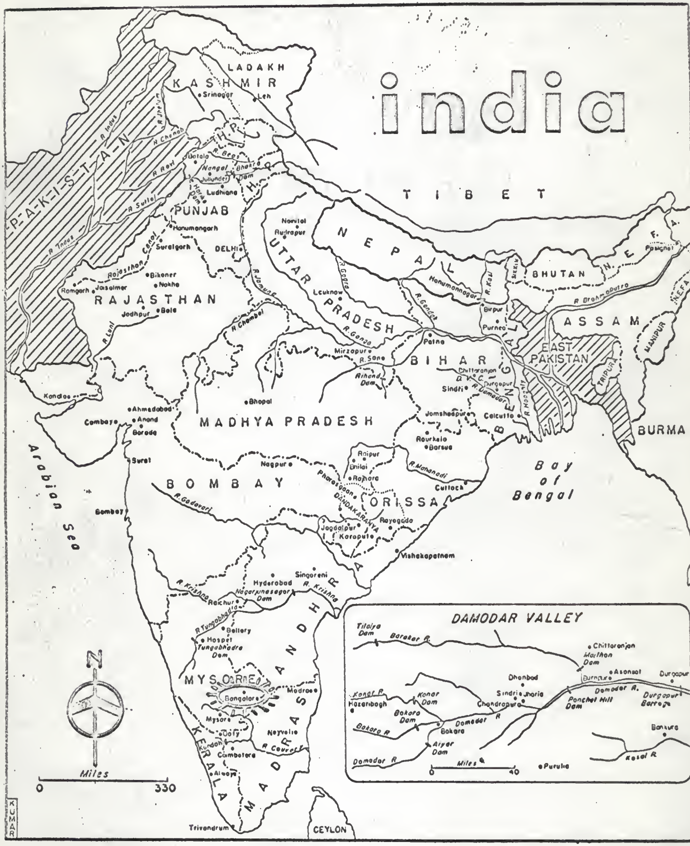
1. The Himalayan highlands extend across the northern border from Kashmir to the Burma frontier. This curves like a scimitar across the north of India to make an almost complete rampart. This region runs for 1,500 miles from the eastern extremity of Assam to the western limits of Kashmir with a breadth varying from 150 to 200 miles. Some of the highest peaks in the world are to be found in this region.

2. The plains of northern India are about 1,500 miles long east to west and

EXPLANATION OF PLATE I.

The map of India, showing its area, physical features, rivers, states and their capital cities.

PLATE I.


india
LADAKH
KASHMIR
Srinagar
Leh
PAKISTAN
R. Indus
R. Jhelum
R. Chenab
R. Ravi
R. Sutlej
H.P.
Batala
Nangal
Bhakra Dam
Jullundur
Ludhiana
Harike Dam
PUNJAB
Hanumangarh
Suratgarh
DELHI
Rajasthan Canal
Bikaner
Nokha
Jaisalmer
Ramgarh
RAJASTHAN
Jodhpur
Bala
R. Luni
Kandla
Ahmedabad
Cambay
Anand
Baroda
Surat
Arabian Sea
Bombay
TIBET
NEPAL
Naini Tal
Rudrapur
UTTAR PRADESH
R. Jamuna
R. Gogra
Lucknow
R. Ganga
R. Gandak
Hanumannagar
R. Kosi
SIKKIM
BHUTAN
N.E.F.A.
Pasighat
NEFA
R. Brahmaputra
ASSAM
MANIPUR
EAST PAKISTAN
TRIPURA
BURMA
Birpur
Purnea
BENGAL
Patna
BIHAR
Mirzapur
R. Sone
Rihand Dam
R. Chambal
Bhopal
MADHYA PRADESH
Chittaranjan
D.V.C.
Durgapur
Sindri
R. Damodar
Jamshedpur
Calcutta
R. Hooghly
Rourkela
Barsua
Bay of Bengal
Raipur
Bhilai
Rajhara
Nagpur
R. Mahanadi
Cuttack
BOMBAY
Pharasgaon
DANDAKARANYA
ORISSA
R. Godavari
Rayagada
Jagdalpur
Koraput
Vishakapatnam
Singareni
Hyderabad
R. Krishna
Nagarjunasagar Dam
Raichur
ANDHRA
R. Tungabhadra
Bellary
Hospet
Tungabhadra Dam
MYSORE
Bangalore
Madras
Mysore
Ooty
Neyveli
R. Cauvery
Kundah
Coimbatore
Alwaye
KERALA
MADRAS
Trivandrum
CEYLON
N
Miles
0
330
KUMAR
DAMODAR VALLEY
Tilaiya Dam
Barakar R.
Chittaranjan
Maithon Dam
Dhanbad
Asansol
Durgapur
Burnpur
Konar R.
Konar Dam
Hazaribagh
Sindri
Jharia
Chandrapura
Damodar R.
Panchet Hill Dam
Durgapur Barrage
Bokaro Dam
Damodar R.
Bokaro
Bokaro R.
Aiyer Dam
Bankura
Damodar R.
Miles
0
40
Purulia
Kasai R.

150 to 200 miles broad. This is one of the most densely populated areas on earth. The plain is broken by intermittent low-lying mountain ranges and is watered by India's three main rivers, the Ganges, the Brahmaputra and the Jamuna which flows southward from the Himalayas to the Bay of Bengal.

3. The Deccan or Peninsula proper is a tableland. It is bounded on three sides by mountains, on the north by the Vindhya and Satpura ranges, on the west by the Western Ghats, and on the east by the Eastern Ghats. This peninsular region is traversed by the rivers Narmada and Tapti, which flow into the Arabian Sea, and Mahanadi, Godavari, Krishna and Kaveri, which flow into the Bay of Bengal.

Climate - Broadly speaking, the climate of India is controlled by two seasonal winds or monsoons. Of these, the Southwest or Summer monsoon blows over thousands of miles of warm ocean before it reaches India, at about the beginning of June, to bring 90 percent of the annual rainfall. By the end of September, the Southwest monsoon begins to retreat and by the beginning of January, the Northeast monsoon blows steadily over the country. During the first four months of the year there is scarcely a place in India outside the Himalayas which receives a single inch of rain.

The Tropic of Cancer passes through the center of India. To the north of this line the climate is rather temperate and to the south of it tropical.

The Meteorological Department of India recognizes four seasons: 1) Cold weather season (December to March); 2) Hot weather season (April to May); 3) Rainy season (June to September); and 4) The season of the retreating Southwest monsoon (October to November).[1]

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[1] The Gazetteer of India, volume I, Publication Division, Ministry of Information and Broadcasting, Government of India, Delhi, 1965, pp. 72-75.

Southwestern and eastern India are distinctly tropical; summers are humid. Central and northern India have hot, dry summers with dust storms prevelent. Winters are mild and pleasant.

Soil - The Indian soil may be mainly classified under four different heads: 1) Alluvial soil; 2) Black soil; 3) Red soil; and 4) Laterite soil.

Alluvial soil is very fertile and covers the greater part of northern India including Punjab, Uttarpradesh, Bihar, West Bengal, parts of Assam and Orissa and also the coastal regions of Southern India.

Red soil covers the whole of Madras, Mysore and Southeast Bombay, east of Hyderabad and Madhyapradesh to Orissa and Chota-Nagpur. These areas are generally of medium to low fertility.

Black soil covers the greater part of Maharashtra and Gujarat, the western part of Madhyapradesh and Hyderabad and some parts of Madras State. Black cotton soil is exceedingly compact being tenacious and sticky when wet. The water holding capacity of this soil is good.

Laterite soil is derived by the atmospheric weathering of several types of rocks under monsoon conditions of alternating dry and wet periods. The soil is found on the summits of the hills of the Deccan, Madhya Bharath, Madhyapradesh and of the Rajmahal hills and eastern Ghats. On the whole these soils are poor.

Constitution - India is a sovereign democratic Republic with a parliamentary form of government based on universal franchise. It is a Secular State and possesses a rich mixture of religions and cultures, which makes it unique and colorful.

Religions - The Aryans, who entered India between the years 2500 B.C. to 1500 B.C., established a Vedic religion, which developed into Hinduism. Today about 83.5 percent of the people of India are Hindus. Among other

religions which originated in India are Buddhism, Jainism and Sikhism and they constitute 0.74, 0.46 and 1.79 percents of the population respectively.

The Mohammedan religion was first introduced into India by Arab traders early in the 8th century. Today they form 10.69 percent of the total population and represent the second largest Muslim population in the world.

It is believed that St. Thomas, one of the twelve Apostles of Jesus, came to Malabar, South India, and established Christianity prior to 345 A.D. Today the Christians of India are the third largest religious group in the Union, comprising 2.44 percent of the total population.

Languages - The constitution of India recognizes 14 regional languages and, based on languages, India is a Union of 16 States and 10 centrally administered territories. In addition, there are also English and about 250 regional dialects. The most widespread of Indian languages is Hindi. The other important regional languages are Bengali, Oriya, Punjabi, Gujarathi, etc. The Dravidian languages prevalent in South India are Tamil, Malayalam, Telugu and Kannada. In addition to many languages and religions in India, there is great diversity in food, dress, habitation, means of transport from one state to other states.

One prevailing characteristic of Indian civilization has always been the principle of allowing diversities to remain, and this has strongly influenced the cultural evolution.

Quite often, however, these diversified groups have become obstacles in organizing and planning on a nation-wide basis.

Dwelling Houses in the Past - It may be relevent here to discuss briefly the types of dwelling houses, which existed in the past and the various factors which influenced their design, shape and form.

The history of Indian Architecture must begin with the buildings of the

great cities which flourished in the Indus Valley about 3000 B.C. They are evident in the recent excavations of Mohenjo-Daro in Sind and Harappa in the Punjab.

The Indus Valley house was conceived as a self-contained unit turned in upon itself. Its external walls were battered and were not pierced by any openings. A single passageway led through from the exterior to the inner court. All windows and doors to the interior opened from the inner court and access to the upper storey was gained by an external staircase. Floors, roof, stairs and lintels were of wood with the superstructure being of burnt bricks.[2]

It seems evident, that the Indus Valley house was designed to have maximum protection from the harsh climate. Thick walls, without openings on the exterior, provided a good solution to control the sun so that the courtyards and interiors of the house remained cool and comfortable in all seasons.

Between 1500 B.C. and 600 B.C., called the Vedic Period, very little archeological evidence has come down to us. The Vedic house was not an elaborate affair and people lived in houses built of thick walls of mud clay with very few openings. Roofs were thatched.

Buddhist literature contains references to well built cities, stately palaces and dwelling houses, during Emperor Ashoka's period (273-237 B.C.). During this period, stone was employed for the first time instead of wood for building construction. Between 200 B.C. and 20 A.D. architecture of dwellings continued the same pattern of courtyard houses.

With the firm establishment of Mohammedan rulers in India during the 12th century A.D., the Indo-Islamic architecture started. A composite

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[2] World Architecture, Part III, McGraw-Hill Book Co., Inc. P. 128, 1965.

building art resulted during this period. Building art in northern India attained its most sumptuous form under the patronage of the Mohammedan dynasty, remaining to influence up to the end of the 17th century.

However, the basic courtyard plan for dwellings and other buildings did not change, except for refinement in shape and proportions of various elements. One notable element introduced was the pierced stone Jalis (Grille) in different patterns to block the rays of sun to outside verandahs to form a dramatic pattern of shadows and allow for refreshing breezes.

The real excellence of Indo-Islamic architecture was attributed to the knowledge and skill possessed by the Indian craftsmen, particularly in the art of working in wood and stone in which they were unequalled.

Percy Brown says, "Briefly, good building is a combination of art and science. The fault with the Indian workman lies in the fact, that he is so supremely artistic, that his art invades the field of science, with the result that his construction too tends to become artistic; in other words, he is an artist first and technician afterwards."[3]

The Indian builder was always influenced by his traditional artistic - decorative skill, which is amply exhibited even in residential buildings, on doors, balustrades, etc. (See Plates II and III).

From the time that the country came under British rule in the 18th century, buildings were designed and executed in an occidental style, but adopted to suit the climatic conditions began to be erected at some of the larger centers. A "Hindu Saracenic" style was established to adapt Indian styles to modern requirements. As far as dwellings were concerned, courtyards, open

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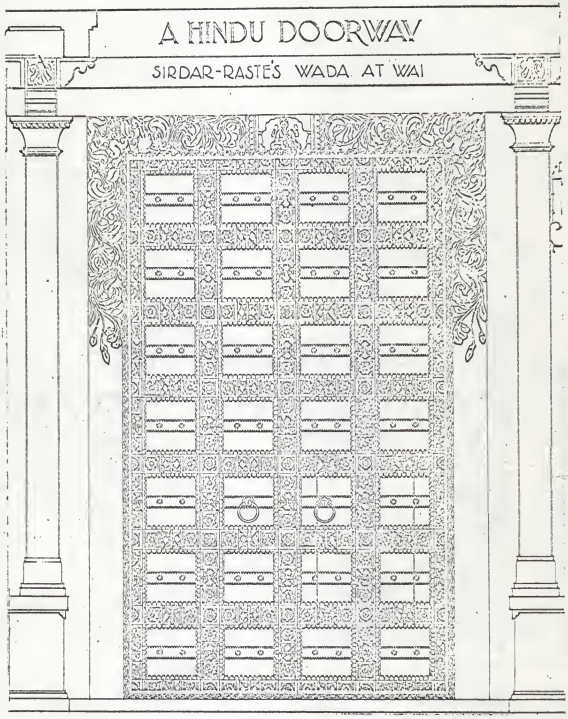
[3]Percy Brown, Indian Architecture (Islamic period), D.B. Taraporewala Sons & Co., Bombay, 1942; pp. 129-131.

EXPLANATION OF PLATE II.

The handicraft on the entrance door of a land owner's house in the small town of Wai in the hills, about 20 miles from Poona, Maharastra, India, built in the later part of the 19th century.

PLATE II.

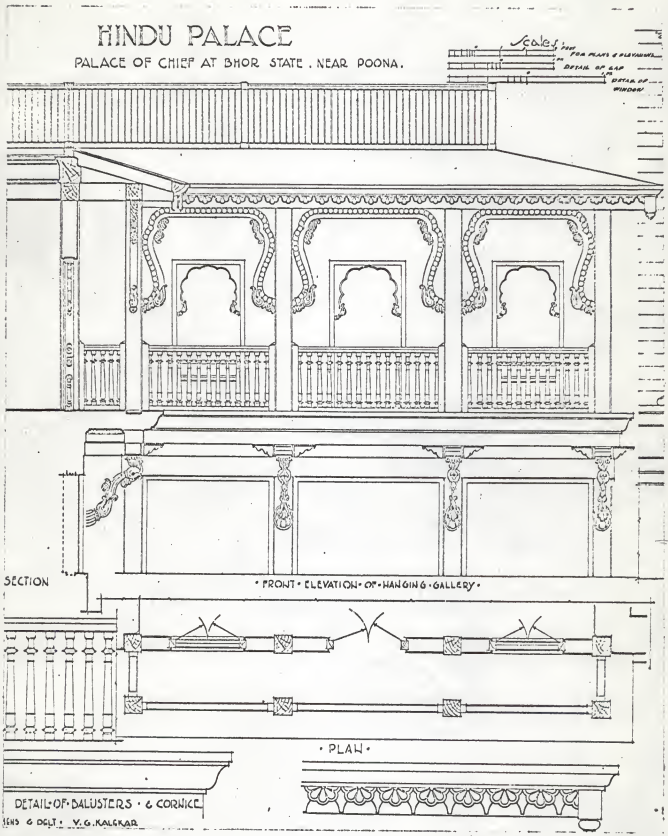


EXPLANATION OF PLATE III.

Details of balusters handicrafted in wood, which decorates the balcony of the palace of the Chief at Bhor State, near Poona. This palace was also built in the later part of the 19th century.

The details worked-out for cornice and eaves of roof are also interesting.

PLATE III.


HINDU PALACE
PALACE OF CHIEF AT BHOR STATE . NEAR POONA.
Scales
FOR PLANS & ELEVATION
DETAIL OF GAP
DETAIL OF WINDOW
SECTION
FRONT ELEVATION OF HANGING GALLERY
PLAN
DETAIL OF BALUSTERS & CORNICE
DELT: V.G.KALEKAR

verandahs and balconies continued to be part of every house, because of their virtues. The materials were brick, stone and wood.

Since independence in 1947, there has been a trend in India to adopt more functionally oriented designs for dwelling houses and to abandon some of the desire for "ornament". However, the progress made in this direction is slow. A new style of modern Indian architecture has yet to be developed, although it has been attempted in Chandigarh, Punjab recently with considerable success.

Housing Situations (At Present) - The problem of housing in India at present is a complex one, requiring finances on a large scale and dependent for its plan and execution on concerted efforts of individuals, co-operatives, State and Union Governments. There is acute shortage of housing in urban and rural areas and much of the available accommodation is qualitatively of sub-standard variety. The shortage in urban areas has been largely due to considerable increase in population.

Before independence, the government of Bombay pioneered to build 15,000 tenements for its employees. By 1949, a special housing board was set up for building houses for industrial workers and other low-income groups. Then improvement trusts were formed in cities of Calcutta, Madras and Kanpur to develop public housing schemes.

In May 1952, a separate portfolio for housing was created by Union Government and organized efforts were being made to step up housing activities throughout the country.

The following table gives the progress done under five-year plans of the Government.

Table 1.

Housing Progress Under Five Year Plans of the Government of India[4]

	Years	Amount Spent	Dwelling Units Constructed
I Five Year Plan	1951-56	#Rupees 385 million	120,000
II Five Year Plan	1956-61	Rupees 2500 million	500,000

[4]India Reference Annual, 1965, published by M. I. & B., Government of India, Delhi, 1965. P. 383.

#One Rupee = $7.50

In addition to the above number, 700,000 houses were constructed by public authorities in I Five year plan period and an amount of Rupees 10000 million is estimated to have been spent by private authorities in II plan period, towards constructing houses.

The following table shows the shortage of houses in urban and rural areas at the beginning of III plan period in 1961.

Table 2.

Households and Houses in 100,000[5]

	Number of Households	Number of Existing Houses	Number of Good Houses	Shortage
Urban Areas	156	141	63	93
Rural Areas	689	651	122	567
Total	845	792	185	660

[5]India Reference Annual, 1965. P. 383.

The III plan proposed Rupees 15650 million on housing and expected to complete about 4.2 million new houses (1.5 million in urban areas and 2.7

million in rural areas) to meet the shortage. The increase in number of households during this period is, however, estimated at 10.5 million (3 million in the urban areas and 7.5 million in rural areas). Thus there would be a further deficit of 6.3 million houses. Another 1.8 million houses are likely to become uninhabitable due to depreciation. Altogether the total shortage of houses at the beginning of IV plan is expected to be on the order of 74.1 million (11.4 million in urban areas and 62.7 million in rural areas).

The above figure indicates the grave situation about housing in India today, in spite of vigorous efforts by government and other private bodies.

There are many factors impeding the progress of housing schemes. Major ones are: 1) shortage of developed land at reasonable prices in and around growing cities and towns; 2) shortage of building materials such as cement and steel; 3) shortage of funds; and 4) shortage of competent technical personnel.

A provision of Rupees 500 crores or 5000 million has been proposed again by the government for housing schemes in IV plan, begun in 1966 and the scheme is being vigorously expedited through various schemes like Subsidized Industrial Housing Scheme, Low and Middle Income Group Housing Scheme, Slum Clearance Scheme, etc.

Therefore, the role of architects and planners to implement these schemes through better and more economical planning is a must. Much thought in terms of using indigenous materials and simple techniques in construction should be encouraged.

Perhaps the main guiding principle of modern architecture is economy: economy of material, economy of means, economy of expression. And the reason why economy occupies the very center of our thought is that it is a sign of

orderly understanding and perfect control.[6]

With this as a guiding factor, even in Indian conditions of relative poverty and simple technology, a vital humanae environment could be created in all the housing schemes.

BANGALORE CITY

General Background - Bangalore, the capital of Mysore State, is rightly called the air conditioned and garden city of India, because of its ideal climate and number of good parks. The average temperature is 73°F with its elevation being 3,000 feet. Its latitude is 12°58' N and longitude is 77°35' E.

Founded in the 17th century by the Hero, Kempegowda, the city of Bangalore came into prominence with the flux of time. The city has grown steadily since 1901 to the present position as one of the 10 largest cities of India.

Blessed with an abundance of flat land for expansion, and other essential facilities, the city was selected for the establishment of several union government heavy industries. Today, Bangalore is a big industrial city having six major national industries (aircraft, telephone, machine tools, electronics) and a number of other state and private industries of smaller scale.

The city covers an area of 36 square miles and its density is 33,527 per square mile. The urban growth and the land use pattern of the city have followed the concentric zone pattern with industries on the outskirts of the city. The city has transportation ties by air, rail and highways, with other important centers of India.

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[6] Lewis Mumford, The Culture of Cities, Harcourt, Brace and Co., New York, 1938. P. 416.

Population Growth - The following table shows the population growth in a decade.

Table 3.

Population Growth of Bangalore Metropolitan Area From 1951 to 1961

	Males	Females	Total	% of Increase
1951	---	---	1,006,115	---
1961	644,047	562,914	1,206,961	20%

The following table indicates the distribution of population according to means of livlihood in Bangalore district (1961 census).

Table 4.

Distribution of Population According to Means of Livlihood[7]

	No. of Persons
Workers in Manufacturing Industries	131,975
Total Number of Workers in All Fields	993,118
Non-Workers	1,511,334
Total	2,504,462

[7] Statistical Outline of Mysore 1964. Department of Statistics Government of Mysore, Bangalore, 1966. pp. 32-35.

It is seen from table 3, that more than 200,000 people were added to the population within a decade, indicating a rapid increase in population. For the most part, this population increase is attributed to industrial developments and services.

It is also concluded from table 4, the number of workers in manufacturing

industries are more than 13 percent when compared to the total number of workers, which is a quite high percentage. Their requirements and well being in terms of housing, etc., should be the responsibility of the employers.

The effect of the sudden increase in population has resulted in a shortage of housing, with the industrial workers suffering most. They are forced to stay in overcrowded, congested, and unhealthful conditions in the city center. Although some good housing developments have been done for some of the major government sponsored industries, many of the industries are still lacking to provide proper housing to their employees. Well planned communities to meet their need and budget are of immediate necessity.

Family Structure - Before we proceed on designing houses or living spaces, we must know the average size and structure of families in Bangalore.

The following table indicates the number of households in each type found among 100 households of a typical town and also of a typical village.

Table 5.

How Many Households of Each Type Would be Found Among 100 Households[8]

Type of Household	Number of Households in a	
	Typical Town	Typical Village
Small (3 members or less)	38%	33%
Medium (4 or 5 members)	41%	44%
Large (7, 8 or 9 members)	16%	17%
Very Large (10 or more)	5%	6%
Total	100%	100%

[8]Census of India, 1951, Vol I, part 1-A-Report, published by the Manager of Publications, Delhi, 1953. pp. 49-50.

From the above table, it is clear that the majority of families are medium size. It is an indication that families do not continue to be "Joint Families" according to the traditional custom of the country and the habit of breaking away from the Joint Family and setting up separate households is quite strong.

In a high percent of cases, the greater the opportunity for profit in any social cultrual situation, the weaker the ties of extended kinship will become.[9]

Recent studies made for the nearby Bangalore area, by T. S. Epstein, also indicates that the traditional Joint Family systems under the impact of economic changes, are breaking up into elementary family systems. She also points out another reason for the breakup of joint family to elementary family unit is the diversification of economic interests and activities.[10]

Hence for design purposes, the average size of a family in Bangalore is taken as 5 persons (medium size).

The Factory and the Housing Site

1. Location - The New Government Electric Factory (NGEF) is located on the outskirts of Bangalore City towards east along National Highway No. 4 (See Plate IV). The factory buildings are situated at a distance of 3/4th of a mile from the highway. The factory almost abutts Bangalore-Madras railway line and is also very close to the Bangalore airport.

This factory was set up by the Government of Mysore under collaboration with Messrs AEG, a West German electric company, in the year 1961. The factory

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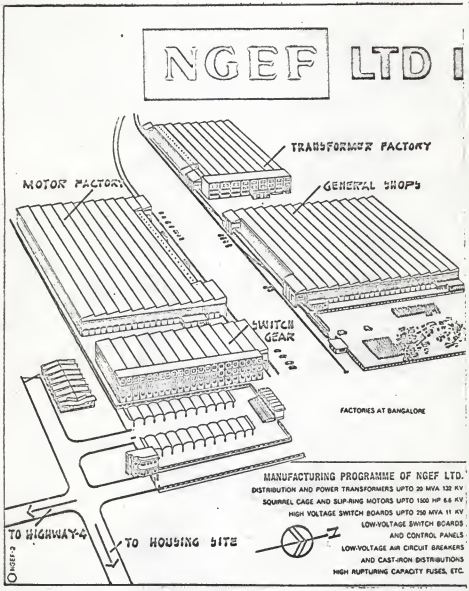
[9] R. Linton, 'Cultural and Personality Factors Affecting Economic Growth', The Progress of Underdeveloped Areas, University of Chicago, 1952. P. 84.

[10] T. S. Epstein, Economic Development and Social Change in South India, published by the University of Manchester, 1962. pp. 176-177.

EXPLANATION OF PLATE IV.

The factory layout showing all the factory buildings, the main gate and the employees cycle stands, in relation to the housing site and the approach road from National Highway 4.

PLATE IV.


NGEF LTD I
TRANSFORMER FACTORY
MOTOR FACTORY
GENERAL SHOPS
SWITCH GEAR
FACTORIES AT BANGALORE
MANUFACTURING PROGRAMME OF NGEF LTD.
DISTRIBUTION AND POWER TRANSFORMERS UPTO 20 MVA 132 KV
SQUIRREL CAGE AND SLIP-RING MOTORS UPTO 1500 HP 6.6 KV
HIGH VOLTAGE SWITCH BOARDS UPTO 250 MVA 11 KV
LOW-VOLTAGE SWITCH BOARDS
AND CONTROL PANELS
LOW-VOLTAGE AIR CIRCUIT BREAKERS
AND CAST-IRON DISTRIBUTIONS
HIGH RUPTURING CAPACITY FUSES, ETC.
TO HIGHWAY-4
TO HOUSING SITE
NGEF-3

manufactures transformers, motors, switch gears, switch boards, etc. The total cost of the project was estimated at Rupees 77.73 million. Five factory buildings with a total floor area of about 72,140 square yards for shops and offices have already been constructed and the factory is presently under full production (See Plate IV).

With the idea of providing a well planned community, including community facilities for their employees, the factory authorities have reserved 90 acres of land in close proximity to the factory towards the east. It is proposed to house 1/3 of the employees in the first stage of development. In the second stage, it is expected to house 2/3 of the total employees.

The proposed site is very gently sloping to the south and is covered by scattered Mango and Neem trees. The gentle slope offers natural surface drainage. Agricultural land abutts the site on its northern and eastern sides. The soil is red with analyses indicating adequate structure well suited for foundation construction.

2. Classification of Employees - The present number of employees is 1,990, of which 840 are staff members and the remaining 1,150 are workers. On the basis of their salaries, the employees are classified under three groups, shown in Table 6.

Table 6. Classification by Income

Groups	Income Per Month	No. of Persons	% to Total Emp. Strength
Higher Income Group	Rupees 500 to 2000	36	1.8
Middle Income Group	Rupees 200 to 500	804	40.4
Lower Income Group	Rupees 90 to 200	1150	57.8
Total		1990	100.0

The 'Higher Income Group' are the managerial, technical and administrative chiefs. The 'Middle Income Group' are supervisory, technical and clerical staff. The 'Lower Income Group' are workers.

3. Climate - The temperature table for each month, drawn for Bangalore, indicates that temperature variations are moderate. The lowest temperatures recorded are 57.70°F and 57.56°F during the months of December and January and the highest temperature being 92.5°F during the month of April. It is also clear from the table (See Table 7) the hottest periods are in the summer months of March, April and May and in some parts of June and coolest periods are in December and February.

Table 7.

Monthly Maximum & Minimum Temperature[11]
Recorded-Based on Data up to 1940

Months	Temperature in Degrees F		
	Mean of Daily Maximum Recorded	Mean of Daily Minimum Recorded	Average
January	80.2°F	57.5°F	68.8°F
February	85.5°F	60.3°F	72.9°F
March	90.1°F	64.7°F	77.4°F
April	92.5°F	69.3°F	80.9°F
May	91.2°F	69.2°F	80.2°F
June	84.4°F	66.7°F	75.5°F
July	81.3°F	65.8°F	73.5°F
August	81.3°F	65.7°F	73.5°F
September	81.9°F	65.6°F	73.7°F
October	81.8°F	64.9°F	73.3°F
November	78.9°F	61.9°F	70.4°F
December	78.3°F	57.7°F	68.0°F

[11] The Gazetteer of India, Vol I, 1965, Pub. Div. M. I. & B., Govt. of India, Delhi, Appendix B, pp. 115-116.

The monsoons, which come from the direction of southwest, occur during the beginning of June and last till the end of September. Infrequently the northeast monsoons come in October and November. The prevailing winds are from the direction of southwest at an average speed of 5 mph. The average annual rainfall is 31". Humidity is no problem.

4. Utilities Investigation - Overhead electric (66 Kv Grid) and telephone are quite close to the site (running along National Highway 4), providing excellent service to the housing area without much expense. The water table at the area is at a depth of 66 feet. Hence, through wells, water is available at an economical depth. Sanitary sewer lines and sewage disposal must be worked out independently.

The proposed community will be a satellite of the city, depending on it for major facilities such as high schools, colleges, hospitals, public parks, clubs, state government offices, bus and railway stations, etc. Of course the essential community facilities like nursery and primary schools, medical center and recreation facilities should be incorporated.

To provide transport service to the industrial belt along the National Highway, the city Transport Department buses on an hourly basis are providing excellent transportation service to the proposed housing development.

The following table gives the distances in miles from the site to various facilities inside the city.

Table 8.

Community Facilities in the City and Their Distances From the Site

	Places	Distances in Miles
1	High School	4.0
2	Colleges	5.0
3	Hospitals	3.5
4	Market Place (Central)	6.5
5	Market Place (Small)	3.5
6	Public Parks	5.5
7	Public Library	5.5
8	Town Hall	6.25
9	Clubs	4.0
10	Airport	2.0
11	Railway Station (Central)	7.0
12	Railway Station (Small)	3.5
13	Bus Terminal (Central)	6.5
14	State Government Offices	4.5
15	Corporation Offices	6.0

APPROACH TO PLANNING

A systematic approach to planning of the whole scheme should start with defining what our objectives, goals and standards are and how best they could be reached. They are discussed in a very broad sense in the following paragraphs.

Objectives - Housing objectives should be the furnishing of healthful accommodations adequately provided with facilities for privacy and comfort, easily accessible to centers of employment, culture and amusement, accessible from the centers of distribution of food supply, rentable at reasonable rates and yielding a fair return on the investment.[12] Further housing goals should be to provide desired community facilities, which are listed below:

1. Utilities - The utilities are water, surface drainage, sewage collection and disposal, gas, electricity, telephone and access lanes or streets.

2. General public facilities - These are schools, hospitals, clinics, health centers, transport, social service, fire protection, parks and playgrounds, meeting halls, museums and libraries.

3. Community facilities - These are market places, stores, repair shops and entertainment facilities.

Standards - The standards of housing differ largely according to the stage of social and economical developments of each country by various social classes. Standards should therefore be considered in relative terms, according to such varying conditions.

The imbalance between the rent and income continues to be a big problem. In order to determine standards, housing cost, and the ability to pay the rent

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[12] Carol-Aronovici, Housing the Masses, John Wiley & Sons, Inc., New York, 1939. P. 2.

within the family budget should be considered.

The housing standard should be set higher in view of the future progress in living standards. The standards of the environment around that dwelling should be evaluated as an integral part of the housing standard, since human life is supported not only by a house, but also by its environment in general.

Solutions to country's climatic conditions and making use of local materials should be included. Local customs should be studied and the design of houses should incorporate them. Open space and density standards should be as high as possible, in relation to streets and utility costs.

Health and sanitation standards with regard to cleanliness, privacy, proper ventilation and good sewage disposal should be set high.

Above all, major emphasis should be given to the social aspects of housing.

The social aspects may be 1) the relation between housing and family; and 2) the relation between housing and community. We may also analyze the housing developments under the following specifics:

Does it permit the family to eat, sleep and perform all daily functions, in accordance with the family's standard of decency and its requirements of privacy?

Does it promote social integration?

Does the family feel the dwelling is a component part of the family institution?

People - Cultural and Social Forces - The major purpose of housing should be to provide its occupants with a safe, healthful, stimulating and enjoyable environment. We cannot achieve this goal, unless we understand that we have to achieve a unity in the economic sense, in the social sense, in the technical and aesthetic senses.

To start with proper perspective, we must try to understand the people, who are part of present housing developments and their culture and social habits.

It must be remembered that in India 80 percent of the people still live in rural villages and only recently has India begun to develop increasing patterns of city life. For many Indians, city living in any form is a new experience and in many cases the tradition and customs derive directly from a rural than an urban situation, with the Bangalore industrial worker no exception.

The three different groups for which we are designing houses are mainly classified according to their incomes. Even though the wide income gap between each group is narrowing and class consciousness is disappearing, due to economic changes and improvements in living standards, yet living habits between each group differ to a considerable extent. The traditional way of life still has a stronghold on the customs and living patterns of the middle and lower income groups. They wish not to destroy the old way of life, with love of present habits governing bathing, food, etc. Among the higher income group, however, the western influence has left its mark in modern trends and comforts. So we have different ways of living and requirements for environment of each income group.

The plan (proposal) should therefore achieve flexibility and individuality, retaining all good community associations. The houses must adapt to various ways of living as well as liberate the occupants from old restrictions.

To analyze further, we must discuss each income group individually to discover minimum space needs and other requirements. Living spaces must be related to family size and characteristics. As discussed in Part II, the average family size in Bangalore is 5 persons. The type of family to be

housed in each income group house may be:

1. A couple with two or more children
2. A couple with children and an old father and/or mother as dependents
3. A couple with children with brother and/or sister as dependents

Generally, in all these families, only the head of the family will be the earning member. But in some cases, both husband and wife may be earning, and the rest of the family dependent. Hence, there is an economic limitation of paying rent, particularly in cases of low and middle income groups. Of course this will not be a problem in the higher income group.

Higher Income Group - They form only 1.8 percent of the total employee strength. They have their own cars for transportation and they go to the city for schools, colleges, shopping and for entertainment. Along with other living spaces, they need large indoor space and outdoor garden areas for social get-together and official parties. They also need garage space for their cars and space for washing clothes and outside drying yards. They have servants who should also be accommodated in the house. They use electricity for cooking and heating purposes and they will have refrigerators. They would prefer all modern comforts and amenities and also club and recreation facility in the housing area.

Middle and Lower Income Groups - They form 40.4 percent and 57.8 percent of the total strength respectively.

The minimum accommodation to be provided in one family dwelling would be two rooms, a kitchen, a living room and a bath room. Among the former group, 75 percent have bicycles and the remaining 25 percent have scooters for transportation and among the latter group 75 percent possess bicycles and the remaining have none. They go to work either by bicycles or on foot and as such they would prefer their houses to be located as close to the factory as pos-

sible. They also need sufficient space for washing and drying their clothes and a space for keeping their bicycles and scooters.

In India, household equipment is generally simple, especially that involved with the preparation of food. All cooking is done over open wood or coal fires. The cooking hearth or 'vole' is usually a brick, stone or concrete block housing a fire pit in its midst with openings in the top over which cooking pots are placed. Although now cast iron coal cooking ranges and kerosine oil stoves are replacing these 'voles', at the price which can be afforded, electric stoves and refrigerators are beyond their reach.

Traditionally, the preparation and cooking of food is done at floor level with the floor serving as a work surface. At present in upper and middle class houses, they prefer 'voles' and sinks at counter height, for reasons of convenience and comfort.

The lower income group would prefer continuing their old custom; the 'voles' may be placed at floor level with a sink (a single tap) added at floor level. They feel more comfortable in this method. The food storage provisions are usually minimal.

The usual bathroom consists of a single water tap, as the customary method of bathing in India is that of dipping water from a pail. Only upper income houses are equipped with showers.

Both the western style water closet and the Indian type at floor level are commonly used. The western types are to be commonly found in upper income houses and the Indian type being consistently used by the other two groups.

The point which should be given importance is the preference of group living. Human contact is very important and is demanded by the Indian way of life.

Housing Developments - The neighborhood unit is particularly suitable to India says, "Albert Mayer", because the poverty of the country makes the people more dependent than in the west on the pleasures of simple community life, the sociability of bazaar, the gaiety of street life and the quiet and coolness of the local park. The lack of automobiles or other transport would make people less able to travel long distances and more likely to depend upon community facilities within walking distance.[13]

Perhaps the earliest realization of the neighborhood unit in modern planning occurred in Forest Hills Gardens, a model neighborhood, developed by Clarence Perry for the Russell Sage Foundation and built on Long Island between 1911 and 1913.

He felt that the basic residential unit should contain the population, which could be served by one elementary school and that, in addition to housing, the neighborhoods should provide parks and recreation areas, convenience shops and civic institutions and an internal street system designed for specific local use. Surrounding the neighborhood would be arterial streets.

Variations of the neighborhood units idea also occurred in Sunnyside Gardens in New York, designed by Henry Wright and Clareence Stein in 1924 and in Radburn, New Jersey, in 1929.

These designs demonstrated great improvements in the design of residential neighborhoods, orienting buildings towards abundant open space and employing such devices as cul-de-sac to keep residential areas free of through motor traffic; system of pedestrian circulation through the parks and the location of schools, recreational and shopping facilities within the pedestrian areas.

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[13] Norma Evenson, Chandigash, University of California Press, Berkeley, 1966, p. 17.

Henry Wright insisted upon the advantages of the row or group house, used at Sunnyside, to improve the planning of both dwellings and the space about them.[14]

Even though the conditions in India differ considerably with the situations in western countries like the U.S., etc., the same principle can be applied with advantage to suit the local conditions, considering the changing trends in modes of living in the future.

The planning of the development will be proposed as follows (See Plate V, page 60). The approach road to the housing site is from a major street running east-west connecting the factory area to the housing area. The major street surrounds the boundaries of the site, which facilitates automobile traffic. On the northern side, an additional approach from the housing area to the north gate of the factory is proposed for reasons that factory expansion will be on the northern side. The housing is to be developed with plenty of open green areas in the enclosed space and central portion of the land is to be left for the development of community facilities. To give physical form to the layout, the "plan organization" of houses, streets and open spaces on the site is necessary.

The principle applied here is to give special considerations to the orientation of buildings, the grouping of each type of houses and tying them with common open areas at the center and also with sufficient open spaces around them. This form of grouping houses would be very appropriate considering the various factors, social, cultural, economical and climatic, as discussed before in this part. It also controls density, which is the key fac-

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[14] The Urban Pattern-City Planning and Design, Arthur B. Gallion and Simon Eisner, 2nd ed., D. Van Nostrand Co., Inc., New York, 1965. pp. 124-125.

tor in planning, establishing the texture of the physical form. Grouping of houses also promotes social integration among the occupants. An integrated community, instead of individual parcel, will become the unit for planning, in contrast to what is done today in government housing projects.

As proposed in the site development plan (see Plate V, page 60), the higher income houses are in groups of 6 to 12 detached dwellings surrounded by open spaces for gardens and outside activities. Access to these houses is from cul-de-sac streets and the number of houses provided is 32.

The middle income houses form a group of 112 living units arranged in 14 buildings of two stories high with large common open space at the center. The number of houses proposed in this type is 224.

The lower income houses are in groups of 8 buildings, each building having 16 living units accommodated on four floors. That means each such cluster consists of 128 dwellings with a common open space at the center. The total number of dwellings proposed in this category is 384.

Approach to the 2nd and 3rd type houses is by pedestrian and cycle paths directly from the major street. In total, the scheme will provide housing for 640 families.

Although vehicular traffic will not be considered a problem, the major street indicated would take care of the traffic which arises from the future expansion of the factory. Streets are asphalt with curb and gutter as required by the existing subdivision regulations. Right-of-way for the major collector street is 64 feet with 44 feet pavement and for the cul-de-sac street, 50 feet right-of-way and 30 feet pavement.

The community facilities provided are: a primary school, a nursery school, a medical center, a recreation center, a library, a shopping center, a bus stand and playgrounds adjacent to schools. All these facilities are

grouped and located at the center to facilitate easy access from the dwelling units. The approach to community facilities are by pedestrian paths. The pedestrian paths are 6', 8', 10', and 12' depending on the amount of pedestrian flow and are paved with concrete.

By locating the above facilities at the center, through traffic is completely eliminated and children do not have to cross the traffic streets to go to schools and play areas. A pleasant environment is provided by introducing a pedestrian court with interesting lighting fixtures, a sculpture piece and sitting benches with shady trees for shopping and relaxation (see Plate V - Section YY, page 60). This area will also be a community focal point.

The dwelling units are proposed close to the factory and the maximum walking distance to the factory is not more than 1/2 mile. As far as possible, houses are located away from the existing railway line. Heavy planting of trees along this boundary will protect the housing area to a certain extent from the nuisance of smoke and noise.

A residential area of low density, having 16 units per acre, is proposed and the gross density being 9 units per acre. For future expansion, 18 acres of land is kept open on the southeastern corner of the site, wherein another cluster of 14 buildings could be easily accommodated and this can be tied without any difficulty to the community facilities area. It is also proposed to put up two additional floors to the lower income buildings in the future and the concrete columns will be designed to take care of this additional load.

Since this thesis is primarily concerned with residential requirements and architecture, these are dealt with in the next part, supported by architectural drawings. Details of buildings pertaining to community facilities will not be included, but general area requirements and their location are indicated on the site development plan.

DESIGN OF DWELLING UNITS

In observing local architecture, one observes a consistent effort to achieve protection from the sun. Here a house is essentially a shade and shelter. There is usually no vast glass area to create interpenetration of exterior and interior. Attention should therefore be given to design cool interiors, amply protected from the southern and western sun. Older virtues of providing verandahs and balconies, introduced properly, can provide good solutions.

It is possible that one day, the widespread use of air conditioning and other mechanical cooling devices may modify Indian living habits, but at present it is necessary and practical to think in terms of providing as much comfort as possible without mechanical devices.

At the same time, the Indian architect should design for the changes anticipated in the future, retaining whatever is good from the past. He must also take the experiences of other advanced countries. Even though the majority of the people in India in urban areas have not developed a liking for apartments in multistoried building, for reasons of economy and to recognize changes which are inevitable, it is good to introduce these type of buildings now and acquaint the people of their advantages.

Bangalore is fast urbanizing. Every day, the price of land is going up and therefore the land should be used economically. Besides, by proposing 2 to 4 storey buildings, we may save land cost, have savings in foundations, savings in thickness and number of walls and economy in plumbing. It also controls density and provides much room for open spaces and by introducing 2, 4 and single storey buildings, variety in design can be provided.

According to Matthew Nowicki, "the concepts of economy and beauty derive

from the same source and the utmost economy is the utmost beauty."[15] Carried out imaginatively, the principle of economy becomes a positive pleasure in building, a sign of right relationship with life.

The dwelling units must be simple in design and construction. The plans should be easy to follow and be implemented by local labor. Standardization of various elements of structure and efficient use of local materials are a practical necessity.

With the above factors as guiding principles, the three different income group houses are proposed in this scheme.

Higher Income Houses - Detached dwellings are proposed with ample garden area and bigger living space (see Plate VI, page 61). As there is a big difference in living standards between this group and the other groups, a little more generous provision of space is proposed and for other group houses, minimum standard requirements of living space are kept.

For a family with children, bedrooms with attached baths and water closet are essential. Three bedrooms, one 14' x 16' and two 14' x 12', are proposed with attached baths. One bedroom serves for the parents and the other two for children. These bedrooms are connected to the main living room by a corridor. This gives room for direct access to bathroom from living room also. The bedrooms are sufficiently segregated for privacy and will have enough closets or wardrobes. Living room and dining are combined and are located immediately beyond the entrance. They will be separated by a movable cane partition, and during the time of social get-togethers or parties, a larger space can easily be created by collapsing the partition. Outside living areas will be part of living and dining rooms. They are very

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[15]Evenson, Chandigash, 1966. pp. 14-15.

useful during hot summer evenings and are located for maximum privacy.

Kitchen, utility and servant's room are attached to dining. Kitchen space will be equipped with sufficient storage space. The sink and the cooking ranges will be at counter height and space for refrigerator is also provided. Utility room will be used for washing clothes and for ironing, etc. A service entrance, near to utility room, would serve as easy approach to outside drying yards.

A one-car garage will be convenient to the entrance and will provide direct access to entrance verandah. A servant's room is proposed close to kitchen and entrance.

The plinth area of each house proposed is 2,400 sft.

Middle Income Houses - The committee set up recently by the Union Government, to report on Industrial Housing in India, recommends that an industrial worker's dwelling may not constitute anything less than two rooms, where each room may have a minimum area of 120 sft. in addition to sanitary convenience, a kitchen area and a verandah.[16] These are the minimum requirements for comfortable and decent living and these minimum requirements are taken into consideration. For this category, row houses in two floors are proposed. Each floor will have 4 houses in a row, making a total of 8 houses in each building (see Plate VIII, page 63).

Front verandahs would serve as entrances to these houses and approach to the second floor is best served by two independent staircases, provided at extreme ends of the building.

Space provided in each unit are two bedrooms of different sizes, the

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[16] D. N. Dhar, Industrial Housing for the Tropics, The Concrete Association of India, Bombay, 1961. P. 13.

smaller one for parents and the larger one for the children. The single bathroom will be very close to sleeping areas and can also be independently approached from living room and kitchen.

Living, dining and kitchen areas will form a big space. The kitchen and dining area will be separated by kitchen counters and living area is separated from kitchen by storage closets. This provides flexibility and at the same time privacy for kitchen.

The main features of the design are an 8 foot front verandah which serves best as an outside sitting area in the evening and rear small verandah, which will be very useful for housewives as a work area and for drying clothes, etc. Ample storage and wardrobe closets are provided.

Space for keeping bicycles and scooters are provided on first floor, behind staircase enclosure. Bathrooms and kitchen of two units are grouped to achieve economy in plumbing.

On the basis of the enlightenment of this group, two basic improvements in living standards have been suggested: 1) the small kitchen for working in an upright position by providing cooking area and sink at counter height as opposed to the usual squatting on the floor type (See Plate IX, page 64); and 2) the distinction between public and private areas in the house. This latter has been emphasized by placing all bedrooms and the bathroom at the rear with complete privacy.

The plinth area of each unit proposed is 1,024 sft.

Lower Income Houses - Four story apartment buildings, having 4 units in each story are proposed (see Plate X, page 65). Bedrooms are separated by wardrobes and closet spaces, with bathroom convenient to them. Living room and kitchen are separated so as to have privacy for housewives. Kitchen serves as dining area also. The cooking platform and sink are at floor level. Storage

spaces are provided by open racks at ground level and upper levels (see Plate XII, page 67).

Each unit is also supplemented by small entrance verandah. Main entrance to the building is at first floor, which is at 4'6" above the ground level. A central staircase located in the lobby provides access to 2nd and 3rd floors as well as access to basement floor. Lobby space at first floor will be utilized for keeping bicycles and in upper and basement floors for drying clothes. Space provision for lift is also provided in the lobby, thinking of future needs.

Plinth area of each unit is 768 sft. and the area of each floor with the lobby space is 3,648 sft.

1. Cross Ventilation - The prevailing summer breezes are from a southwest direction. Hence, the buildings are oriented on the north-south axis. By staggering and grouping each type of building, all rooms will be able to get some breeze. Cross ventilation is maintained in all buildings, by proper positioning of openings in the plan. Even where wall partitions come in the interiors, 1'-0' high wooden louvered ventilators will be provided above the door shutters, so as to have continuous circulation of air and thus maintain a comfortable temperature inside the room. Openings will have mosquito screens which will prevent dust and insects from entering the houses.

2. Sun Control - Proper orientation of buildings could control sun to a greater extent. Experimental models of all the three types of buildings were made and their orientations were studied for sun paths of June 22 (summer) and December 21 (winter) for Bangalore.

The higher income houses will be oriented on north-south axis. In summer months most part of the building will be under shade, especially during hot afternoon hours and at winter outside verandah adjoining dining room will be

able to get morning sun. West is also protected by introducing blind wall of thick masonry for living room and providing concrete grilles for corridor, which serve as sun brakers and also with weather shades for openings (see Plate VII, page 62).

The middle income houses are oriented both on north-south and east-west axes with 8 feet verandah facing either south or east. These verandahs will be under shade during hot summer afternoon and evening and would serve as comfortable outside sitting areas for the occupants. Also these verandahs will be able to get morning sun, when it is needed during winter season (see Plate VIII, page 63).

The lower income houses will also be oriented on north-south axis. The shape of the building itself will keep northern and eastern wings and most part of southern wing under shade during summer afternoon (see Plate V, page 60).

In all the buildings, southern sun is controlled by providing 3 feet wide horizontal weather shades for openings. Eastern and northern sides are not much of problem. As far as possible western sides are protected. Another way to protect is by planting trees for shades on the west and south sides, where heat and glare are intense most of the day. In Bangalore, trees grow easily and advantage can be taken of this to simplify the problems of shade.

Insulated roofs may be necessary to avoid the heat also. By using proper insulating material over roof, this can be reduced. The material proposed here is brick bats mixed with limestone and cinder and finished on top with lime mortar. This is economical and proved to be quite efficient locally to minimize heat. The exterior surface will be given pure white wash, which will also reflect heat. Ceiling fans will be introduced for further advantage. Since Bangalore weather is considered moderate, the methods adapted now would take care of the heat during summer periods.

3. Materials - In India, one should rely mainly on local materials, as they are economical and can be easily handled by the local workmen. Available in plenty in Bangalore, however, are locally made bricks with good clay and fine granite and above all cheap human labor. With advantageous use of these materials, definite reduction in cost can be achieved.

A brief account of the available materials in Bangalore with their relative merits are given in the following paragraphs.

a. Bricks - There are two types of bricks available in plentiful supply in Bangalore: a) Country Bricks (kiln dried and burnt)

b) Machine Mould Wire Cut Bricks (kiln dried and burnt)

The usual size of bricks manufactured are 9" x 4½" x 3". The wire cut bricks have uniform size, color and density and they are quite strong and are superior to country bricks. The country bricks are economical to use, but the disadvantage of these bricks are breakage (15%) while handling.

The usual practice at Bangalore is to construct walls in thickness of 1 1/8' in country bricks and plaster on both sides. This plastered surface will also have the disadvantage of requiring frequent maintenance. Hence, it is proposed to use 9" thick exposed wire cut brick walls for lower and middle income houses. Exposed bricks and concrete weather well and require little up keep and thus encourage considerable savings in maintenance. For the other type houses 1 1/8' brick walls plastered are proposed to have variety of form and surface, since maintenance will be no problem among this group.

The cost analysis, worked out for 100 sft. of wall surface proves that 9" thick wirecut brick walls are economical for larger scale use and will have the same strength as 1 1/8' country brick walls. The tradition of the familiar workmanship coupled with the small price of labor, prove to be the decisive argument for using bricks for walls in all buildings.

Cost Analysis	Cost in Rupees
Country Brick Wall (1 1/8' thick) (plastered on both sides)	190
Wire Cut Brick Wall 9" thick (plastered inside, pointed outside)	175
Difference	15

b. Stone - Surroundings of Bangalore are full of granite quarries and it is the most commonly used material for public buildings and for foundations. Bangalore granite has an even texture and uniform color and can be used for pattern walls. Even though the cost of stone will not differ much to the cost of bricks, the disadvantage of thickness plus dressing cost, limits its use for superstructure in residential buildings. However, for blind walls and foundations, it can be used with greater advantage.

c. Cement - Mysore State has two cement factories. One is at Ammasandra, about 70 miles from Bangalore and the other one is at Bhadravati, which is about 165 miles from Bangalore. Therefore, enough cement is available for construction work and can be used for buildings. But it should be used economically, since cement is still an expensive item.

d. Steel - Mysore has an iron and steel factory at Bhadravati. Therefore, mild steel bars are available in sufficient quantity for reinforced concrete. But bigger items like beams, girders, channels, angles and tees for window frames are not readily available in huge quantities and if available in smaller quantities, are still expensive items. Hence their use as structural members are restricted to big factory buildings.

e. Wood - Well seasoned teakwood is available in different sections and lengths. It is brown in color, takes good polish and can be easily worked. It is very durable, fire resistant, lasts in water and not attacked by white

ants. This is extensively used for doors and windows of residential buildings because of its good qualities and reasonable price.

f. Plywood - Factory made plywood boards are available in different widths and lengths and also in thickness of 1/8" to 3/4". They can be economically used for partitions, doors, and built-in wardrobes and closets.

g. Precast Concrete Items - Precast concrete structural elements have not been significantly developed in Bangalore. There are few small scale factories, who often restrict their manufacture to concrete grillework and precast water tanks, etc. for residential buildings.

With simple design, precast R. C. joists and hollow tiles for floors and roofs can be developed for greater economy and easy handling. Besides, these items will not be difficult to manufacture in large scale in these factories and with simple mouldings they can even be manufactured on site and thus save transportation.

h. Mosaic Tiles - Factory made mosaic tiles in different colored chips are available. The size of tile will be 10" x 10" x 3/4". They stand for good wear and tear and retain good polish. Its use should be restricted to higher income houses, as it is comparitively expensive to the concrete floors with red ochre finish on top surface.

4. Construction -

a. Walls and Foundations - Nine inch thick wire cut brick walls are constructed with cement mortar (1:6). Outside surface will be exposed and cement pointed (see Plates IX and XII, page 64 and 67). For apartment buildings, reinforced concrete columns and beams are proposed as structural members. This is done for several reasons:

1. To reduce the unnecessary thickness of walls, which are common in multistoried buildings of regular foundations and thereby economy.

2. Greater flexibility in arranging spaces and partitions inside the building.
3. Reduction in width and depth of foundations.
4. Ease of expansion. As lift facilities and finances are available, two floors can easily be added in the future.

One and one-eighth foot thick country brick walls are constructed with cement mortar 1:6 and outer surface will be plastered with cement mortar 1:4. Interior wall surfaces of all buildings are plastered with lime mortar 1:2. Lime mortar is proposed, as it gives a smooth surface for painting and also to restrict the use of cement. Non-load bearing partition walls in all buildings will be $4\frac{1}{2}$" thick with hoop reinforcement along the joints at intervals of 2 feet height. Foundations for all houses will be of granite stones in c.m. (1:6) laid over cement concrete bed of 6" thick in proportion of 1:4:8. (See Plate IX, page 64, for details.)

b. Roof - Flat roof will be employed because it is economical, a customary method and handled easily by local workmen. The usual type of roof is $4\frac{1}{2}$" to 6" thick reinforced concrete flat slab, cast on site over centering built out of casarina poles, bamboo sticks and earth. Firstly, this method of centering or shuttering work is inferior and quite often it leaves uneven surface on roof and floor slabs, which necessitates the plastering of ceiling. Secondly, a lot of time is wasted in curing the concrete laid (about 21 days) and thereby continuity of work will not be there.

To overcome these deficiencies and suggest improvements, precast reinforced concrete joists and hollow tiles are proposed for roofs and floors. They are light and can be easily handled on site. The size of hollow tiles proposed are 1'-$9\frac{1}{4}$" x 11 5/8" x 6", and the joists sections can be economically adopted up to a span of 16'-0". (See Plate XIII, page 68, for details.)

Table 9.

Precast R. C. Joists for Spans up to 16'-0" for Floors and Roofs

Precast R. C. Joists Designed For A Superimposed Load of 40 lbs. + Floor Finish of 20 lbs. + Self Weight						
	Joist Size		Reinforcement in Joist		Cost Analysis	
Clear Span	Depth	Width	Nos.	Dia.	Precast R.C. Joist and Hollow Tiles Floors and Roofs	Cast in Situ R.C. Slab 5" to 6" Thick
6'-0"	7"	2½"	1	3/8"	Rupees 270/100 sft	Rupees 350/100 sft
7'-0"	7"	2½"	1	1/2"		
8'-0"	7"	2½"	1	1/2"		
9'-0"	7"	2½"	1	5/8"		
10'-0"	8"	2½"	1	5/8"		
11'-0"	8"	2½"	1	5/8"	Net Saving Rs 80/100 sft	
12'-0"	8"	2½"	1	3/4"		
13'-0"	8"	2½"	1	3/4"		
14'-0"	8"	2½"	2	5/8"		
15'-0"	8"	2½"	2	5/8"		
16'-0"	8"	2½"	1 1	3/4" 5/8"		

It is seen from the above table, that a saving of Rupees 80/=per 100 sft has been achieved by adapting precast R. C. joist and hollow tile floors and roofs. Considering the 640 houses to be built, the savings in this item alone will be quite substantial.

In case of floors, after the tiles and joists are put in position, 2" thick 1:2:4 concrete is poured over with nominal reinforcement and the surface finished smooth with cement mortar and slurry mixed with red ochre.

Over the roofs, 4" thick light surki concrete which consists of brick bats, limestone and cinder will be put as weatherproof course. The top surface will be sloped and rendered smooth by lime mortar to drain off the rain water. The surki concrete acts as thermal insulation and the surface will be

painted with pure white to reflect heat. All buildings will have 1'0" high brick parapet walls with concrete coping on the top to prevent water percolation in walls. The rain water collected at different parts are taken down through 4" dia asbestos cement pipes and where it reaches the ground, concrete guides are provided to avoid scouring action.

c. Floors - Floors which are proposed at 6" above ground level, will consist of $1\frac{1}{2}$" cement concrete finish with red ochre over a bed of 4" thick cement concrete (1:4:8) over 6" minimum rubble soling laid over compacted earth (see Plate IX, page 64). For higher income houses, mosaic tiles are laid with cement mortar directly over 4" (1:4:8) concrete bed and the flooring will then be polished and waxed.

d. Doors and Windows - All doors are factory manufactured and windows are manufactured on site. They are standardized to have 2'-6" and 3'-0" shutter widths for doors and 1'-6" shutter widths for windows (see Plate XIII, page 68). The entrance door and other doors leading to rooms through which furniture is likely to be shifted are 3'-0" wide and the rest only 2'-6". The height of windows are fixed at 4'-6" and at top it will have movable wood louvers for allowing breeze. All windows and doors are made of teakwood, the size of frames being 2" x 4" and the door shutters will be flush type hollow core and $1\frac{1}{4}$" thick. They may either be painted or polished. Windows will have straw mats for curtains and can be rolled to keep in position at top.

5. Interiors and Furnishing - The interior arrangements and furnishing proposed for living room in higher income house is shown in Plate VII, page 62 . Interesting lampshades and movable partition between dining area and living area are made out of cane, simple and artistically woven by the local craftsmen.

The traditional woodwork introduced at the entrance verandah and concrete grille in pattern provided for corridors, gives Indian touch and adds to the architectural qualities of the building. Bedrooms and dining areas will be sufficiently furnished. Built-in wardrobes in bedrooms will be made out of plywood sheets and teakwood battens. Interior of walls will be painted with light colored plastic paints and ceiling white and exterior walls will be given light grey wash of waterproof cement paint. The floor covering will be left to the taste and luxuries of the occupants.

In the case of other two type houses, they cannot afford expensive furnishing. Cane furnishing are proposed for living rooms. (See Plate XI, page 66). They are elegant, durable and less expensive. Furnishing includes a "diwan", 2'-6" x 5'-6" and 1'-6" high, having cotton cushions and bolsters, covered with colorful, local handwoven fabrics, two chairs and two small stools. The diwan can be converted into a bed, when needed to accommodate guests. Locally made coir mats will cover the floors.

Traditional way of eating is at floor level, sitting on 2'-0" x 1'-6" straw mats, with 1'-6" x 1'-6" x 0'-6" wooden stools serving as tables to eat. The same type are retained in lower income houses, as they like that way and it is also cheaper.

Interior wall surfaces of these income group houses will be painted with light colored distempers, as they are less expensive when compared to plastic paints and ceilings with white for better reflection of light.

Incandescent lights in wall brackets are suggested for these houses. They provide necessary indirect lighting and also locally manufactured brackets in different patterns are available at reasonable price. Ceilings will be provided with fans.

Site Development -

1. Landscaping - Landscaping has an important role to play in the planning of any residential community. Of course its main goal or aim would be to improve and intensify the quality of its environment. With proper landscape planning, a pleasant environment can be created. At the present scheme, landscaping has two important functions to provide.

Firstly, to provide much needed shade for the pedestrian paths and also for buildings. The open areas, at the center of each group of houses, will find much use as common activity areas and even to have communal festivals and ceremonies. When planted with trees, shrubs and lawns, these areas will be pleasant spaces for children to play and grow.

Secondly, planting of thick trees along the major street toward south would help to block the smoke and noise caused by trains running close by, as the prevailing winds are from a southwest direction. With these factors in mind, the landscaping has been proposed in this scheme (see Plate V, page 60).

2. Outdoor Spaces - Outdoor living becomes a necessity when indoor spaces become uncomfortable in very hot summer days. In higher income houses, outdoor paved areas adjoining living rooms are proposed with garden. In other two types of houses, verandahs and balconies from bedrooms would prove to be very useful. Also the paved pedestrian courts provided with sitting benches, lighting fixtures and fountains would serve as nice outdoor sitting areas for relaxation and enjoyment (see Plate V - Section XX, page 60).

3. Services and Utilities - Efficient system of drainage, garbage and trash removal, sewage disposal, water supply and electricity have been particularly neglected in India and this neglect has been one of the causes for the sub-standard conditions in housing. Hence, special attention has been given for services and utilities in this housing scheme.

a. Drainage - All bathrooms will be installed with necessary sanitary fittings and drainage lines. The waste lines from the sinks and soil lines from the water closets join the main soil stack and house drain. Branch vents and stack venting will be provided to avoid trap-siphonage. In all houses, bathrooms and kitchen are grouped together in order to minimize the lengths of drainage lines and all sanitary fixtures are located close to outside walls to make the plumbing connections easy.

In first and second type houses, each bathroom consists of a water closet (western style) of size 22" x 27" with low level tank, a lavatory 18" x 20" and a shower stall 3'-6" x 3'-6". The kitchen will have a sink 2' x 2' and a water tap will be provided in utility room.

In the other type an Indian style water closet with tank of size 1'-2" x 1'-9", a lavatory 18" x 20" and a shower stall 3' x 3' will be provided. The kitchen will have a 2' x 2'-6" sink at floor level.

The house drains which carry soil and waste water are connected to common house sewer in each group of houses, which will then be taken and connected to sewer mains, located in the major street, and the waste carried will then go to sewage disposal plant by gravity flow. In the case of basement floors, the sewage will be lifted to gravitation drains by means of pumps.

The sewage disposal and treatment plant will be located at lowest point, towards southeast, sufficient distance away from the housing area. The estimated amount of sewage flow for disposal is 40 gallons per capita per day.

Four general types of operations for sewage treatment were considered: 1) waste stabilization ponds; 2) activated sludge; 3) trickling filter; and 4) factory built treatment plant. It is proposed to use the No. 4, as this method proved advantageous over the other systems, because a minimum amount of space is required, the cost of operation is low and the system is easily exapndable by adding more units as the need arises.

b. Garbage and Trash - Garbage and trash will be collected every day by trucks, employed by the factory authorities and taken to an area off the site, where it will be burned in large incinerators.

c. Water Supply - Potable water is available at a depth of 66 feet in sufficient quantity, which requires minimum treatment. The water consumption will be about 60 gallons per capita per day for all purposes. The total consumption will be 200,000 gallons. This includes requirements for housing, schools, shopping, medical center, etc.

Two large wells, supplying 100 gallons per minute per well, should prove adequate and will be installed. Water pumped from these wells will go to purification plants and thereafter purified water will be pumped up to elevated storage tank. The location of the elevated tank will be at the highest level, at northwestern corner of the site. The exact height and size of the tank will be calculated by the experts on the job. This requires details of piping system for the whole housing scheme, allowable pressure heads to the several fixtures in the houses in different floors and frictional losses. Water for fire protection can be provided by adequate mains and hydrants located throughout the development and also level in the water tank should take care of the minimum pressure for fire hydrants. From the elevated tank, purified water will flow to the housing area by gravitation.

In case of 4 story buildings, independent tanks of sufficient capacity will be located on top and the water will be pumped from the mains and stored every day.

d. Electricity - Electricity is no problem. 66 Kv Grid power line is very close to the site and also the city's power plant is not far away from the site and the Government Electricity and Power Department would be very willing to supply the required power, since the factory is the collaboration of State Government.

The distribution system will be underground, contrary to existing systems in Bangalore housing projects, and this is by far the most satisfying method as it avoids unsightly poles or wires to interfere with the view or compete with trees and other plant life. Another advantage is easy and cheaper maintenance being at ground level.

Cost Estimate - The estimated cost of completed house per each type of dwelling unit and the approximate cost of the total project is given in the following table. The cost of each type of unit, includes the cost of water supply, sanitary and electrical installations, but excluding cost of land and other developments. The estimate does not include cost of furnishing; however, a provision of Rs 2000, Rs 1000 and Rs 750 will be made for higher, middle and lower income houses.

Table 10.

Cost Estimate of the Total Project

	No. of Dwelling Units Provided	Plinth Area of Each Unit	Rate Per Each Unit	Cost Per Each Unit	Total Cost
Higher Income House	32	2400 sft	Rs 14/sft	Rs 33,600	Rs 1075200
Middle Income House	224	1520 sft	Rs 11/sft	Rs 16,720	Rs 3745280
Lower Income House	384	912 sft	Rs 9.5/sft	Rs 8,664	Rs 3326976
Total	640				Rs 8147456

The rates taken here for the purpose of preparing cost estimate, are the schedule of rates adopted by Public Works Department, Government of Mysore, Bangalore, for the year 1966.

Total cost of all buildings = Rs 8147456
Total cost of furnishing = Rs 576000

Grand Total = Rs 8723456

or = $1,163,127

The finances of the project will be the responsibility of the State Government, since it is government sponsored industry.

The rent for each type of unit will be fixed on the basis of the money spent on each unit and also the paying capacity of the occupants, and the rent will then be deducted from their salaries as part of return on the investment. Incentives may also be given to own the houses if desired by the employees with a provision of paying the cost of houses on long term installment basis with low interest rates. This would help both the employees and the government.

GENERAL CONCLUSIONS

The problem of housing confronts every country, industrially advanced or developing. The problem of developing countries like India is essentially that of low cost housing. The need for reducing the cost of construction is however an abiding problem and equally so is the need for providing more comfortable dwellings. It is true that economy should be the center of thought, but not at sacrificing the quality of design. The appreciation of the maxim, "cheapness and economy are not synonymous," would help greatly towards proper thinking in planning houses.

As discussed in this thesis, there is great need and urgency for housing, more particularly industrial housing, throughout the breadth and length of India. The need for speed and enthusiasm for industrial housing both conspire to create slums; therefore the quality of designs cannot be overlooked. With the vast sums that are being invested in industrial housing, the importance of seeing that they will not degenerate into future slums is a major consideration.

The danger is greater, when we know that there are only 38 town planners

and about 400 architects to serve 439 million people. The result is inevitable; most of the vast construction that is going on is being carried out by people who are either poorly trained for their job or not trained at all. With all these deficiencies, if the huge programme in housing undertaken by the government is to be successful, judicious planning is required in the future. Innovations in the planning of residential communities should be encouraged. The more competent persons, the architects, landscape architects, planners and engineers should be consulted to prepare comprehensive development plans for these communities.

If the amenity of space on the earth were related to the common denominator of the human being, the importance of density rather than the type of dwelling structure or the size of a lot could be employed as the desirable control for residential planning. It is within the space of this wide gap that conventional subdivision practice require overhauling. Density control also suggests an approach in planning and this approach may open further opportunities in land planning.

In order to control the quality of design, the government and the local planning authorities should discourage cheap housing developments by speculators and time to time the local subdivision regulations and building codes should be revised to meet the new planning concepts.

The proposals made in this thesis do not pretend to solve all the problems concerning industrial housing. It is only hoped that the proposals might give some insight towards improved design and planning concepts.

To summarize the improvements suggested in this thesis:

1. The advantage of group housing. These suggest improvements in land planning, when compared to commonly adapted individual lots, with their wasteful land use. The examples of existing projects in Bangalore with their cheap

type of houses and wasteful yards would explain better. (See Plates, Appendix A and B). This grouping of houses reduces streets, increases recreation space and reduces cost.

2. Introducing apartment buildings, cost per each unit is reduced to more than 50%, when compared to individual houses.

3. Reduction of wall thickness and avoiding outside plastering, by employing better quality bricks. This solves maintenance problem and results in savings in masonry quantity.

4. Use of prefabricated members for floors and roofs. This eliminates scaffolding and avoids necessary waiting for curing. The man hour saved and the convenient scheduling results in economy. This is also based on premise that older methods should be replaced by mechanization or mass produced elements.

5. Improve the quality of environment through proper site planning principles.

It may be appropriate to add at the end a simple statement made by "Le-Corbusier" in his book, Vers Une-Architecture, 1923. It says "that adequate housing is the solution to all social problems". If not all, much of the social problems in India could be solved by providing healthy housing environments through improved methods and techniques.

ARCHITECTURAL DRAWINGS

The following pages include the architectural drawings (Plates V to XIII). These are plans, elevations, sections, perspectives of the three types of dwelling units proposed and the site development plan. It is hoped that these drawings will analyze the spaces and other requirements provided.

PLATE V

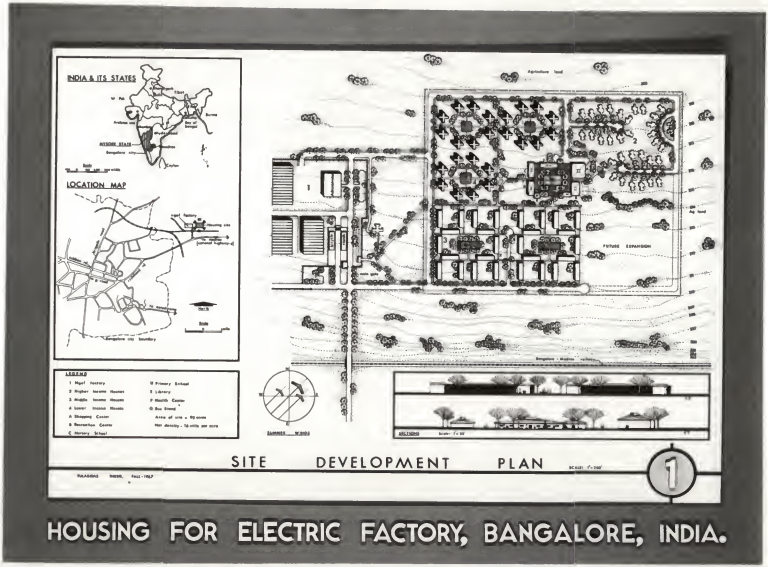
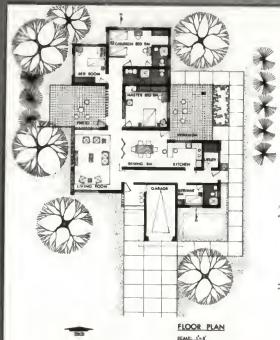
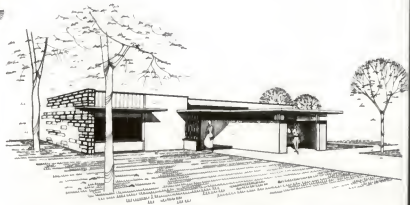

INDIA & ITS STATES
LOCATION MAP
KEY PLAN
LEGEND
1 Major Factory
2 Higher Income Houses
3 Middle Income Houses
4 Lower Income Houses
5 Shopping Center
6 Recreation Centre
7 Nursery School
8 Primary School
9 Library
10 Health Center
11 Bus Stand
Area of site = 92 acres
Net density - 16 units per acre
FUTURE EXPANSION
SECTIONS
SITE DEVELOPMENT PLAN
HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE VI



FLOOR PLAN



ENTRANCE VIEW

HIGHER INCOME HOUSES

2

HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE VII

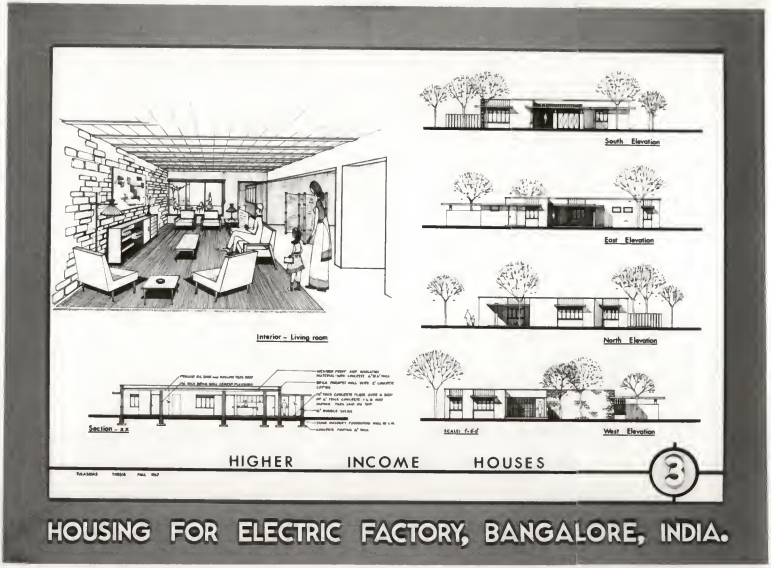

Interior – Living room
South Elevation
East Elevation
North Elevation
West Elevation
Section – X-X
HIGHER INCOME HOUSES
3
HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE VIII

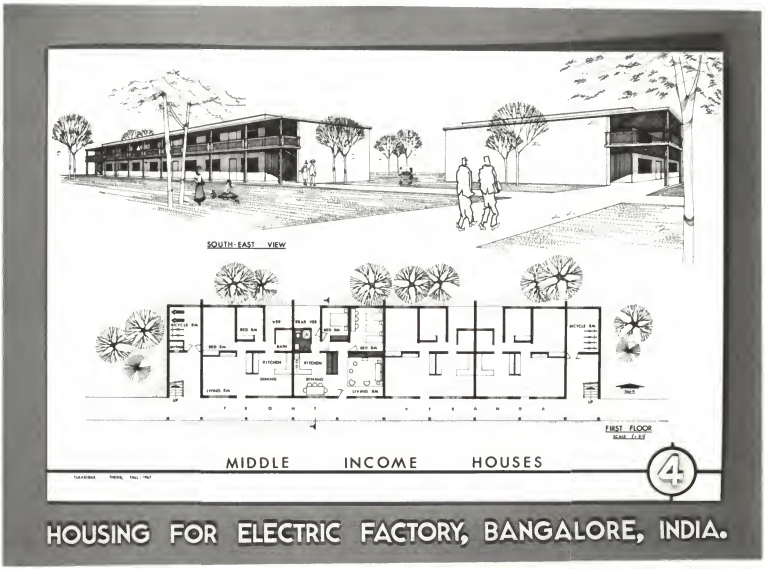
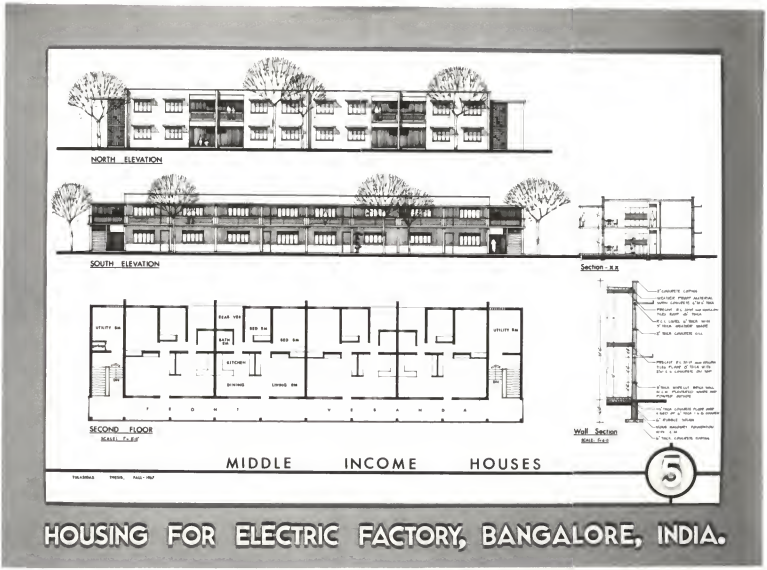

SOUTH-EAST VIEW
FIRST FLOOR
MIDDLE INCOME HOUSES
4
HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE IX


NORTH ELEVATION
SOUTH ELEVATION
Section - x x
SECOND FLOOR
Wall Section
MIDDLE INCOME HOUSES
5
HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

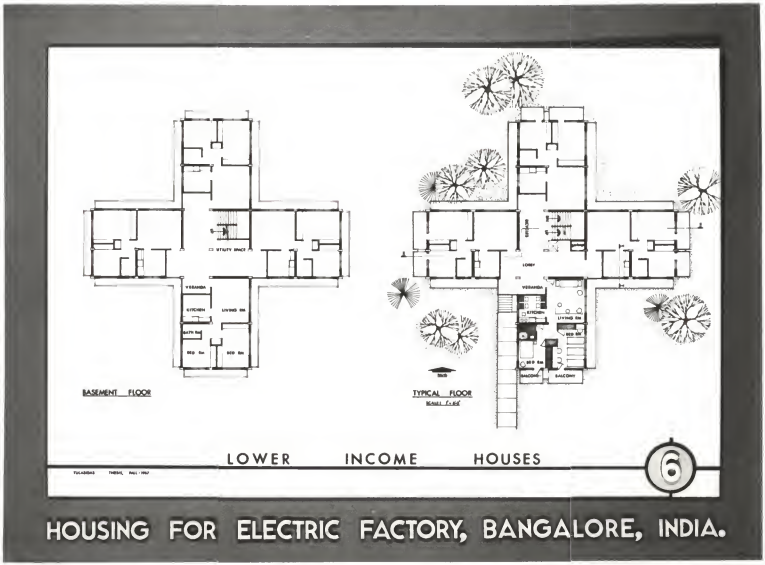

STUDY SPACE
VERANDA
KITCHEN
LIVING RM
BATH
BED RM
BED RM
BASEMENT FLOOR
LOBBY
VERANDA
KITCHEN
LIVING RM
BED RM
BED RM
SHADOW
BALCONY
TYPICAL FLOOR
LOWER INCOME HOUSES
6
HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE XI

ENTRANCE VIEW

INTERIOR - LIVING ROOM

LOWER INCOME HOUSES

7

HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE XII

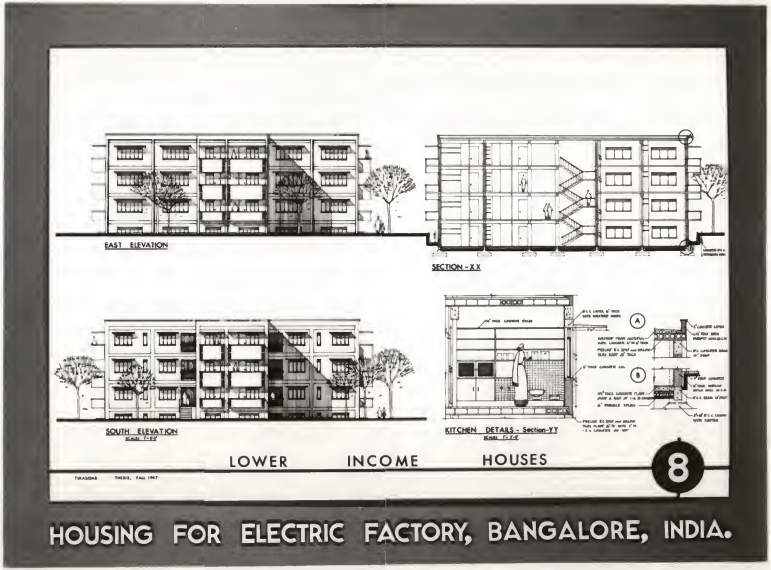
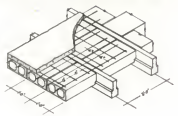
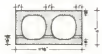
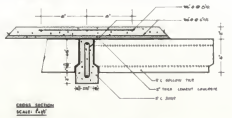

EAST ELEVATION
SECTION - X X
SOUTH ELEVATION
KITCHEN DETAILS - Section-YY
LOWER INCOME HOUSES
8
HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

PLATE XIII

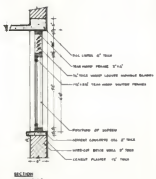
DETAILS OF PRECAST R.C. JOIST & HOLLOW TILES







TYPICAL WINDOW DETAILS



CONSTRUCTION DETAIL

9

HOUSING FOR ELECTRIC FACTORY, BANGALORE, INDIA.

ACKNOWLEDGEMENTS

The author wishes to express his deep appreciation to his major advisor, Dean Emil C. Fischer, for his suggestions, counsel and encouragement concerning the preparation of this thesis.

He also wishes to express sincere appreciation to his committee members, Professor Henry Wright of the College of Architecture and Design and Assistant Professor Dennis J. Day of the Landscape Architecture Department for their advice and valuable suggestions.

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APPENDICES

EXPLANATION OF APPENDIX A

Figures (1) and (2) (photographs) show the type of houses built for lower income employees at the Hindustan Machine Tools Factory Housing, Bangalore. The disorganized and wasteful individual lots with their fenced front yards and unsightly electric poles illustrate the difficiencies of the existing planning.

APPENDIX- A

fig- 1

fig- 2

EXPLANATION OF APPENDIX B

Figures (1) and (2) (photographs) show the middle income houses built for the Hindustan Machine Tools Factory, Bangalore. Here again individual lots are provided surrounded by streets, which has resulted in increased number of streets and wasteful spaces and thus added to more expenses.

APPENDIX-B

fig- 1

fig- 2

HOUSING DEVELOPMENTS FOR ELECTRIC FACTORY, BANGALORE, INDIA

by

KUDIGE B. TULASIDAS

B. E. Civil, Government College of Engineering, Bangalore, India, 1959

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARCHITECTURE

College of Architecture and Design

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1967

Today in India, Industrial Housing is gaining importance and is receiving the long needed attention. The country is fast getting industrialized and every day new factories are coming up in many of its cities or the existing ones are expanding rapidly, and they are becoming the center of a changing phase in Indian economy. Therefore, better and proper housing to the industrial workers, within the reach of their low incomes, has become the growing concern of the government and the employers alike.

To study the problem of Industrial Housing, the city of Bangalore, India, was selected. This particular city was selected because in recent years many national heavy industries have been established here and today it is one of the major industrial cities of India faced with housing problems.

Hence, this thesis is a study of housing developments for one such industrial establishment, the "New Government Electric Factory", Bangalore. The present study is an attempt to develop a scheme which might offer better solutions to the problem of housing industrial employees. The objective is to provide a well planned community of higher quality than those which are existing today in Bangalore, and for that matter in many of the cities of India.

In developing this scheme, sociological, economical, climatic and other aspects are taken into consideration. These aspects are well incorporated in the plan forms and in the site development plan. The basic concept in this scheme is an integrated community. Each income type houses are grouped and are integrated in such a way that all community facilities are to be within the easy walking distance of the occupants. The scheme also promotes social integration among the different income groups, which is one of the important factors.

The design of the dwelling units are influenced chiefly by the minimum space requirements, cross ventilation, sun control, outdoor spaces and also the locally available materials and construction techniques. The main building materials used are kiln bricks, granite stones, cement, precast R.C. joists and hollow tiles for floors and roofs, teakwood for windows and doors. The methods proposed for construction are simple and standardized, which can be understood and handled easily by the local workmen.

Special attention has also been given for landscaping and for efficient service facilities, like drainage, sewage disposal, garbage and trash removal, water supply and electricity in order to provide safe, sanitary and healthy dwelling units.

The proposals advocate healthful, pleasant and comfortable living units to the industrial employees, through better design and planning concepts.